

EFFECT OF ELECTROLYTE COMPOSITION ON CARBON ELECTRODE PERFORMANCE

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INTRODUCTION

Rechargeable lithium cells containing lithium foil anodes are reported to have limited cycle life (at 100% 1101 D) performance and safety problems. These limitations are understood to be due to the high reactivity of elemental Li with the electrolyte and the formation of high surface area Li during cycling. To mitigate these problems, several lithium alloys and lithium intercalation compounds⁽¹⁾ are being investigated as alternate lithium anode materials. Li_xC has been identified as a promising lithium anode material due to its low equivalent weight, low voltage vs. Li, and improved stability towards various electrolytes⁽²⁾. At JPL, we have identified a commercially available graphite material as candidate material for the fabrication of carbon anodes. A number of electrolytes are presently being evaluated at JPL for use with the Li_xC anode. The results obtained so far indicate that the electrochemical performance of this material is dependent significantly on the nature of the electrolyte employed. In this paper, we report the results of our studies on the electrolyte evaluation for the Li_xC anode.

EXPERIMENTAL

The electrochemical performance of the graphite material was investigated using half cells employing Li as the negative electrode and graphite as the positive electrode. Mixed solvent electrolytes containing ethers and carbonates were investigated in this study. LiAsF_6 and LiPF_6 were studied as electrolyte salts.

Carbon electrodes were fabricated by a pressing method. Ethylene propylene diene monomer (111' DM) was used as a binder in the fabrication of the electrodes. Experimental spirally wound sealed cells (1 Ah) were constructed for performance evaluation. These cells contain elemental lithium anodes and carbon cathodes. Lithium foil obtained from Foote Mineral Corp. was used as is. Porous polypropylene (Celgard no. 2400) was used as the separator material. The cells were activated with different electrolytes. All the cell assembly operations were carried out in an oxygen and moisture

free glove box.

The experimental cells were evaluated for charge/discharge characteristics, faradaic utilization of the carbon active material, rate capability and cycle life. A constant current method was used for charging and discharging the cells.

RESULTS AND DISCUSSION

The incorporation of Li into the carbon can be accomplished effectively in two steps as reported by us earlier (3). During the first step, electrolyte decomposition was found to be taken place in addition to the lithium intercalation into graphite. In the first step, electrolyte decomposition at the carbon surface appears to be the major electrochemical reaction. During the second step, intercalation of lithium into carbon appears to be the major electrochemical reaction. The voltage of the carbon electrode as a function of discharge capacity during the first step for two different electrolytes containing different amounts of ethylene carbonate (EC) is given in Figure 1. From the figure, it can be observed that electrolyte decomposition is higher in the electrolytes containing more EC. The rate capability of the carbon electrode in these two different electrolytes is given in Table I. These results clearly suggest that cells containing more EC showed higher rate capability. The higher rate capability of this cell is probably due to the higher electrolyte conductivity of the electrolyte with more EC. Evaluation of cells containing other electrolytes is in progress.

SUMMARY

The electrochemical intercalation of lithium into carbon was investigated in several mixed solvent electrolytes containing ethers and carbonate. The results obtained so far indicate that electrolyte decomposition occurs at the carbon electrode surface during the initial stages of the discharge process. The extent of decomposition was found to be significantly dependent on the electrolyte composition. Electrolytes containing higher percentage of EC showed higher electrolyte decomposition. The cells containing more EC in the electrolyte showed higher rate capability. Hence, a tradeoff in the electrolyte composition may be necessary to obtain higher rate capability and to minimize electrolyte decomposition at the carbon electrode.

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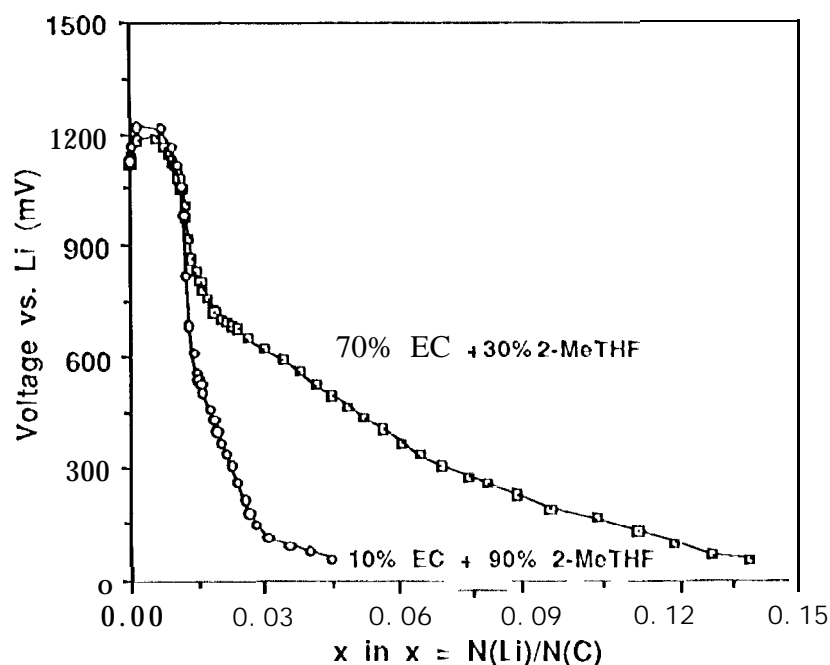


Figure 1. The comparison of Li reaction in Li/Li_xC cells with different electrolytes.

TABLE 1. Rate Capability Comparison of Li/Li_xC Cells with Different Electrolytes (1.5 M LiAsF₆ in EC+2-MeTHF) Composition

RATE	CAPACITY DELIVERED(mAh)	
	70% E C	10% E C
C/20	777	698
C/10	702	663
C/5	684	635
C/3	657	597